Circulation Patterns in Kachemak Bay

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Introduction:

Kachemak Bay is located at the interface between land and ocean waters and thus near the juncture of major oceanographic and land-based processes. Watershed influences on the intertidal and bay habitats range from freshwater input, transport of nutrients, sediments and contaminants to topographic influences on winds and precipitation amounts and rates. Outer Kachemak Bay receives oceanic, upwelled water from the Gulf of Alaska, while the inner bay is more estuarine. The inner bay water column is seasonally stratified, with warmer, less saline waters near the surface (Abookire et al., 2000)

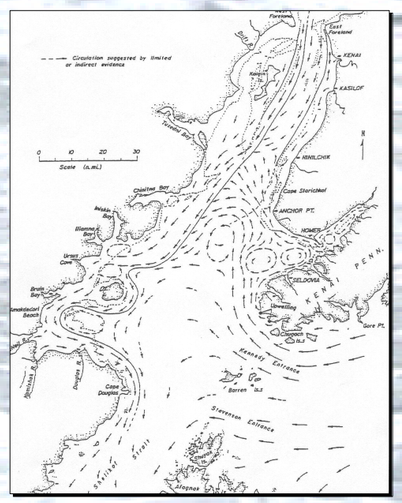

Figure 1: Net surface circulation in Kachemak Bay and lower Cook Inlet (Burbank, 1977)

Proposed Circulation Patterns:

Burbank (1977) proposed the existence of several important gyres and eddies at the entrance to and interior of Kachemak Bay (Figure 1). This observation was consistent with surface current measurements in 1977 (Frisch and Weber, 1980). Since that study however, no subsequent studies have further elucidated the spatial and temporal extent of the surface gyres.

Previous studies of Kachemak Bay have concluded that the circulation of water in the bay is complex and reflects the combined influences of diurnal and monthly lunar inequalities in tidal forcing, seasonal changes in the tidal regime, meteorological effects and fresh water forcing (Wennekens et al., 1975). Dye dispersion studies in tributaries to Kachemak Bay (e.g., Bradley River) have shown that the upper bay is very well-mixed due to the vigorous tidal regime (Colonell, 1980).

The movement of water in this region is critical to understanding ecosystem dynamics such as larval dispersal, habitat distribution as well as for predicting patterns of pollutant (e.g. oil) dispersal. The currents and eddies predicted for the entrance to and interior of Kachemak Bay could be extremely important for localized movement and shoreline deposition of organic matter and pollutants such as oil.

Acknowledgements:

Many thanks to Carmen Field for her assistance in constructing and deploying drift cards as well as her guidance and mentoring activities for the Homer High School mentoring program.

Funding for this study has been provided by a grant from the Exxon Valdez Oil Spill Trustees Council

Drift Card Study:

Drift cards are being used to infer regional surface currents. Drift cards were constructed and deployed over two different seasons and for five different locations. Locations for deployment included: Anchor Point, Beluga Slough, Homer Spit, Seldovia and Bear Cove. Each deployment contained 1000 cards distributed evenly across a transect perpendicular to the shore locations (figure 4). These locations are also consistent with regional data collection. Volunteers from the local community were involved in retrieving and tracking the positions of drift cards.

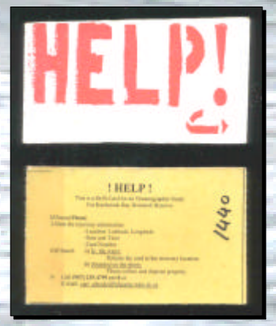

Figure 2: Example of both sides of the varnished wood drift cards used in this study

Figure 3: Deployment of Winter drift cards (March 2002).

Results from Spring/Summer Drift Card Deployment:

Drift card retrieval results are plotted in Figure 4 (a-f) from the May to June 2001 deployment. These results indicate that in the spring to summer season there is no surface current into inner Kachemak Bay. This surface circulation is presumed to be limited by the seasonal density driven surface current flowing out of the bay (driven by the less dense glacial runoff and riverine input).

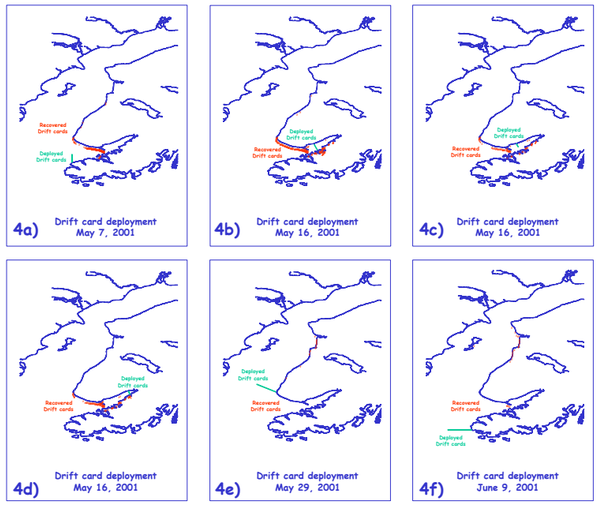

Figure 4: (4a-f): Maps of lower Cook Inlet and Kachemak Bay showing the location of May and June drift card deployment transects and the related retrieval locations of cards from each deployment. Note that during these deployments, all cards which were deployed outside of Kachemak Bay were subsequently retrieved outside of the inner bay, indicating the absence of a surface current entering the inner bay during this season.

Figure 5: Map of lower Cook Inlet and Kachemak Bay region showing location of March 2002 drift card deployment transect.

Figure 6: Landsat image of Kachemak Bay. Note the turbidity plumes clearly showing the movement of freshwater out of the bay.

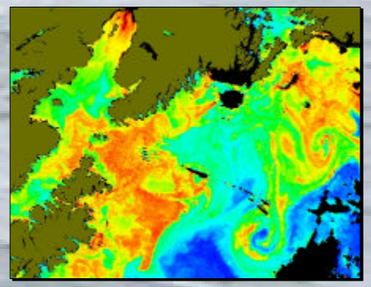

Figure 7: SeaWifs image of the Gulf of Alaska, showing chlorophyll concentration in red.

Winter Drift Card Deployment:

A winter (March) deployment of drift cards was located near Seldovia in order to investigate the existence of a seasonal surface current into the bay (Figure 5). Results from this deployment are not yet available, however contrary to the spring/summer deployment results, we expect to find cards being carried into the inner Bay from the deployment outside. We hypothesize that the winter mixing eradicates the summer stratification, allowing for a seasonal surface current to enter the bay.

Seasonal Surface Current Pattern

A summer surface current flowing out of the bay is consistent with Landsat images which clearly show the movement of freshwater out of the bay (Figure 6). Here the Wosnesenski River is diverted south around the Herring Islands and then to the north. These observations are also consistent with Burbank's proposed surface circulation gyres (Figure 1). SeaWifs images from the Gulf of Alaska also show the chlorophyll signature remaining along the shelf break and outside of Kachemak Bay (Figure 7).

Future Work:

More research is needed to clarify seasonal circulation patterns in the region, as well as the relevant spatial and temporal scales for long-term monitoring. To address some of these needs, two research efforts are underway:

1) A database of vessels operating in the Cook Inlet and Gulf of Alaska regions is being organized by the Cook Inlet Keeper. This database of vessels could be used to identify volunteer vessels of opportunity for use in future projects examining oceanographic variables on multiple spatial and temporal scales.
2) A towed instrument array will be deployed along identified transects in Kachemak Bay (Figure 8). The goal of these preliminary efforts will be to identify the relevant spatial and temporal scales for future data collection.

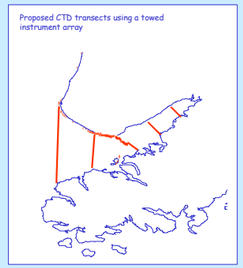

Figure 8: Proposed transects in Kachemak Bay for future data collection.

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